(12) UK Patent Application (19) GB (11) 2 005 170 A

(21) Application No 7829188
(22) Date of filing 7 Jul 1978
(23) Claims filed 7 Jul 1978
(30) Priority data
(31) 288147
(32) 5 Oct 1977
(33) Canada (CA)
(43) Application published
19 Apr 1979
(51) INT CL²
B23D 43/04
(52) Domestic classification
B3L 3F
(56) Documents cited
GB 1303118
GB 1140841
GB 592888
US 3946472A
(58) Field of search
B3L
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(54) **Broaching tool for curved surfaces**

(57) A broaching tool is described having an elongated tool body 20 with an arcuate face of preferably half-round configuration. A plurality of recesses are formed on the arcuate face, each having a flat bottom face 26 inclined inwardly and rearwardly within 1-15° of coincidence with the longitudinal axis of the body and an arcuate abutment wall 27 perpendicular to and rearwardly surrounding the flat bottom face 26. These recesses are arranged in helical paths of increasing diameter in a rearward direction to form a series of spaced helical rows. Each recess contains a rotatably indexable cylindrical cutter disc 24. This configuration of broach has the advantages of providing excellent chip clearance between the cutter and also providing a uniform load on the tool during broaching.

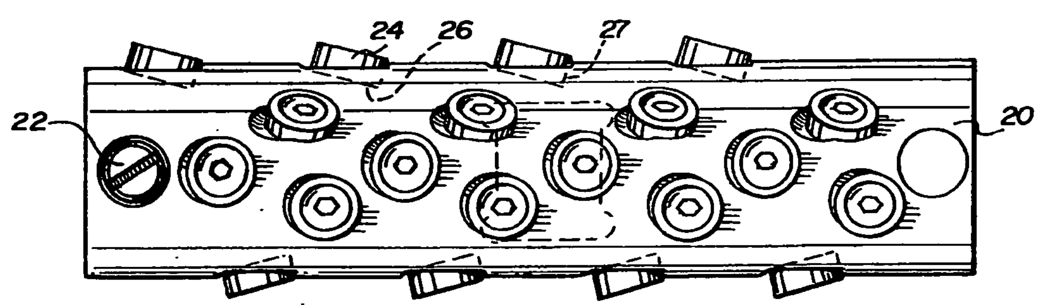

FIG. 2

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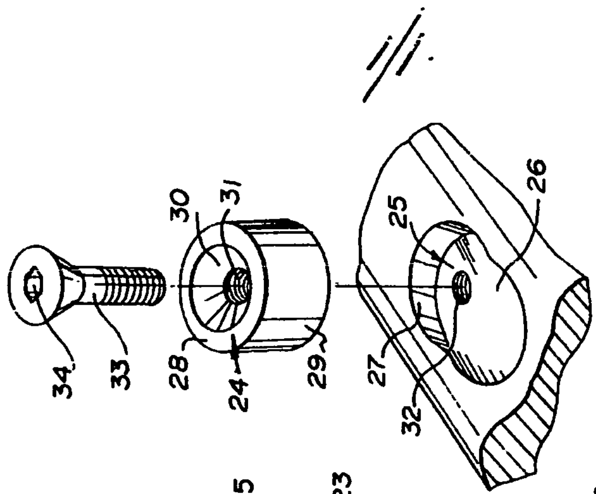

FIG. 5

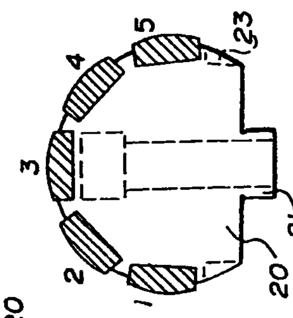

FIG. 3

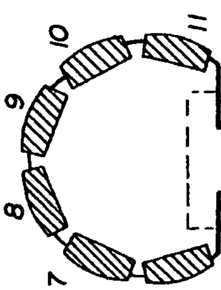

FIG. 4

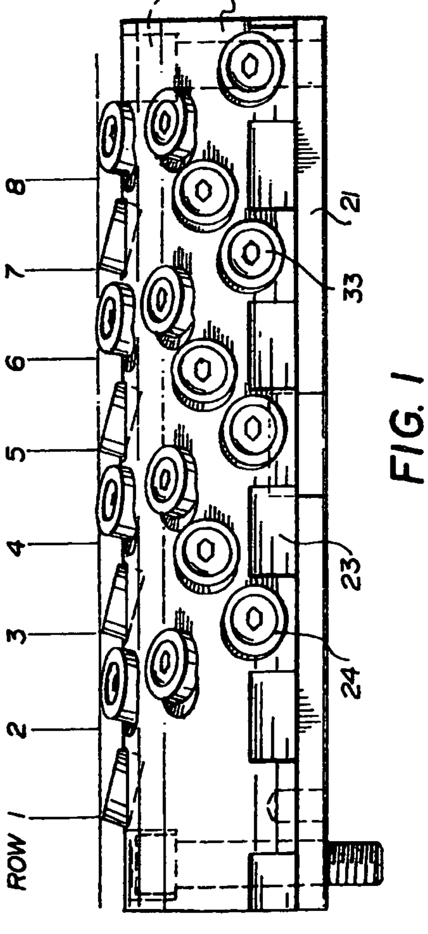

FIG. 1

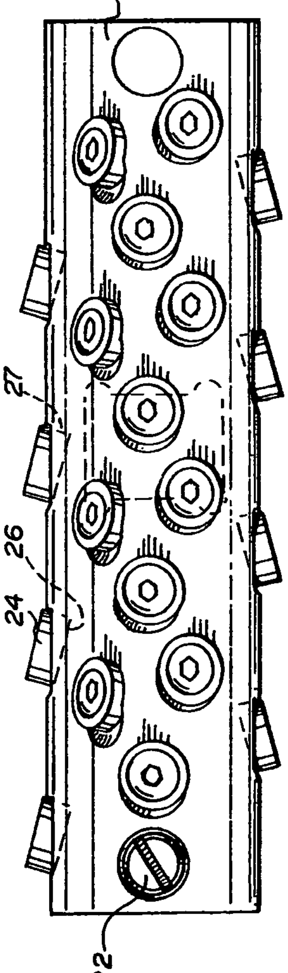

FIG. 2

SPECIFICATION

Helical broaching tool for curved surfaces

The present invention relates to a broaching tool of the type typically used to produce a round hole or a semi-circular hole.

Broaching is a machining process whereby one or more cutters with a series of teeth are pushed or drawn entirely across a workpiece and is analogous to single-stroke filing. Broaching is typically carried out on manually-operated presses, on pull-screw machines or on hydraulically actuated broaching machines or presses. The broach has teeth which increase in height towards one end and is typically held in the screw socket of a broaching machine screw or ram by a taper cotter. Usually the first few teeth on the broach are low to permit the small end of the tool to pass through a hole in the workpiece, while the intermediate teeth remove most of the metal and the last few teeth finish the surface to size.

The typical broaching tool presently in use is in the form of an elongated body having a plurality of spaced annular ribs generally transverse to the longitudinal body of the axis. A series of titanium carbide teeth are brazed onto side walls of these ribs in a position perpendicular to the longitudinal body axis. Each of these teeth has a curved upper cutting edge. Of course, when these cutter teeth become worn, it becomes a very expensive proposition to remove the worn teeth and then braze new cutter teeth into position against the ribs. Also, because each cutting edge engages the workpiece at substantially 90°, it will be appreciated that immense stresses are placed on the tool and the cutter teeth particularly when broaching metals.

In Proulx et al., U.S. Patent 3,946,472, issued March 30, 1976, there is described a broaching tool in which cutter teeth in the shape of buttons or discs have been successfully used for the broaching of concave surfaces. This had the unique feature of being able to make use of the angular positioning of the discs so as to form a smoothly curving contoured surface. Although this represented a great improvement over the previous broaching tools, it did have some problems. Thus, for most broaching tools it was necessary to provide chip relief gaps between the rows of cutter discs so that chips formed would be dispersed easily and not become jammed between cutter discs thereby creating difficulties. Moreover, because the cutter discs were arranged in parallel rows, very heavy instantaneous loads were placed on the tool as each row came into engagement with the workpiece.

It is, therefore, an aim of the present invention to provide an improved configuration of cutting tool for the broaching of concave surfaces in which the chip dispersal is simplified and the tool is provided with a substantially uniform loading during operation.

According to the present invention there is provided a cutting tool comprising an elongated tool body having an arcuate face of at least 45° with a plurality of recesses formed in said arcuate face, each said recess having a flat bottom face inclined inwardly and rearwardly within 1-15° of coincidence with the longitudinal axis of the body and an abutment wall extending upwardly from and rearwardly surrounding said flat bottom face, said recess bottoms lying on helical paths about said tool body arcuate face to form a series of spaced helical rows with a helical path at one end of said tool body having a diameter greater than that of a helical path at the other end of said tool body and the recesses of each row being staggered circumferentially with respect to the recesses of the next adjacent row whereby the paths of successive recesses partially overlap, cylindrical cutter discs being mounted in said recesses, each disc having an end face providing a cutting edge disposed about the periphery of the end face and being rotatably indexable about its longitudinal axis to bring successive cutting portions into cutting position.

The arcuate face forms an arc of at least 45° and usually at least 90°. For a typical half round broach the arc will be in excess of 180° and it may even form a full cylindrical broach. The helical path normally defines an angle of about 5° to 95° with respect to the longitudinal axis of the body and a typical tool has a helical angle in the order of about 15° to 45°.

The helical paths at the rear end of the tool body have larger diameters than the paths at the front end so as to produce a progressively larger hole as the cutting tool is moved through the workpiece or the workpiece over the cutting tool. Preferably, the diameters increase stepwise from the front to rear end, with the diameter differences between adjacent helical paths normally being quite small, e.g. in the order of about 0.01 cm. It is also possible to arrange the stepwise increase such that two or more adjacent paths have identical diameters.

The angle of the cutter discs with respect to the longitudinal axis of the body can be varied within the range of about 1-15°. By setting the series of small round cutting discs at a small angle with respect to the longitudinal axis of the body, the cutting edges of the cutter discs thereby form small arcs of a much larger circle than the diameter of the discs themselves. This, combined with the overlapping of the successive cutters due to the staggering arrangement of cutters in successive rows, results in the depth of grooves formed in the finished surface being very small. Normally, the discs are arrange to broach a hole having a radius at least three times the radius of the individual cutter discs.

The tool body without the cutter discs in place is also novel and represents a feature of the present invention.

The present invention will now be further described by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a side elevation of one embodiment of the novel broaching tool:

Fig. 2 is a top plan view of the broaching tool shown in Fig. 1;

Fig. 3 is a cross section through row 1 of the tool of Fig. 1;

Fig. 4 is a cross section through row 2 of the tool of Fig. 1; and

Fig. 5 is an exploded detailed view of a cutting disc and socket.

The particular broach illustrated in the drawings is known as a half-round broach. It has an elongated tool holder body portion 20 having a bottom spline 21 extending along the length thereof for retaining the tool in a tool holder. The tool is held rigidly in place in the holder by the mounting screws 22.

At the lower edges of the cylindrical surface are provided a series of pockets 23 and these serve as interlocks with adjacent flat broaches which may be used in conjunction with the half-round broach.

A series of cutter discs 24 are mounted in sockets 25 in the cylindrical surface. Each of these sockets has a flat bottom face 26 which is inclined at a small angle of typically about 11° to the longitudinal axis of the body portion 20 and the socket also has a semi-circular abutment wall 27 which is perpendicular to the bottom face 26. Extending into the body portion 20 through face 26 is a tapped hole 32.

Each cutting disc 24 has a cylindrical wall 29 and end faces 28. A hole 31 is formed axially through the insert with a conical countersink 30. The cutting disc is typically made from tungsten carbide. It is held in position by means of a threaded screw 33 which has a conical head portion which mates with the countersink of the cutting disc and the head of the screw includes a socket 34 for receiving a wrench. When the cutting disc has been placed in position in the socket 25 and the screw tightened, the insert is pressed firmly against the abutment wall 27. Thus, when the broach is in operation the forces on the cutting inserts are fully carried by the abutment walls 27 rather than by the screws themselves.

With this arrangement, it will be seen that only about one-quarter of the cutting edge of the cutter discs is in use at one time. This means that as the portion in use becomes dulled, the screws 33 can be loosened and the cutter discs can then be rotated sufficiently to present fresh cutting edge portions, after which the screws are again tightened. The result is that as many as four cutting edge portions may be available on one face of a cutter disc. Furthermore, it is possible to make the discs reversible so that another four cutting edge portions may be available on the reverse face. In this way as many as eight fresh cutting edge portions may be obtainable from a single cutting disc.

A typical cutter disc may have a diameter in the range of about 1 cm to about 2.5 cm and these are used in cutting holes having a diameter of at least 2.5 cm.

In Figure 1 eight helical rows of cutting discs are shown and these are indicated as rows one to eight. Figure 3 shows the positioning of the cutter discs for what are designated as rows 1, 3, 5 and 7 in Figure 1 while Figure 4 is a cross-section showing the position of the cutter discs for the rows designated as 2, 4, 6 and 8 in Figure 1. Particularly from Figures 3 and 4 it becomes evident that the successive rows of cutting inserts are positioned in a circumferentially staggered manner. Thus, the axes of the cutting inserts of row 2 are positioned midway between the axes of the inserts of row 1 while the inserts of row 3 are in alignment with the inserts of row 1. The diameter typically is increased by an amount of about 0.01 cm from one row to the next following row. However, it is also possible to have two of more adjacent rows of the same diameter, followed by two or more rows of increased equal diameter. It is also sometimes desirable to have the last cutting insert of one row at the same elevation as the first cutting insert of the next following row.

One of the advantages of this helical configuration is that specific chip gaps are not necessary since the spacing between cutting discs in the helical configuration is increased thereby permitting easier flow of chips between cutters. The second and most important advantage of the helical configuration is that during operation some of the discs will always be under load. This overcomes any tendency of impact as successive rows of cutting discs come into engagement with the workpiece. This feature will be evident from Figures 1 and 2 so that each cutting disc of each row comes into engagement with the workpiece successively and during engagement with the last cutting disc of one row, the workpiece is already coming into engagement with the first cutting disc of the next row. This greatly decreases the tendency of damage to the broach as well as possible breakage of the workpiece being broached from impact.

While the above preferred embodiment illustrates a screw connection for mounting the cutting inserts in the sockets, it will be readily apparent to those skilled in the art that many other kinds of mounting means are possible. Thus, wedging pins, etc. can be used.

It will also be apparent to those skilled in the art that although a half-round broach is illustrated, similar types of broaches forming arcs of less than a semi-circle or as much as a full circle are within the scope of the present invention.

CLAIMS

1. A cutting tool comprising an elongated tool body having an arcuate face of at least 45° with a plurality of recesses formed in said arcuate face, each said recess having a flat bottom face inclined inwardly and rearwardly within 1-15° of coincidence with the longitudinal axis of the body and an abutment wall extending upwardly from and rearwardly surrounding said flat bottom face, said recess bottoms lying on helical paths about said tool body arcuate face to form a series of spaced helical rows with a helical path at one end of said tool body having a diameter greater than that of a helical path at the other end of said tool body and the recesses of each row being staggered circumferentially with respect to the recesses of the next adjacent row whereby the paths of successive recesses partially overlap, cylindrical cutter discs being mounted in said recesses, each disc having an end face providing a cutting edge disposed about the periphery of the end face and being rotatably indexable about its longitudinal axis to bring successive cutting portions into cutting position.

2. A cutting tool as claimed in claim 1, in which each helical path defines an angle of about 5° to 95° with respect to the longitudinal axis of the tool body.

3. A cutting tool as claimed in claim 2, in which the arcuate face containing the cutter discs forms an arc of at least 90°.

4. A cutting tool as claimed in claim 2, in which the arcuate face containing the cutter discs forms an arc of at least 180°.

5. A cutting tool as claimed in claim 2, in which the arcuate face has an increasing diameter in the rearward direction.

6. A cutting tool as claimed in claim 2, in which the diameters of the helical paths increase step-wise from one end of the tool body to the other end.

7. A cutting tool as claimed in claim 6, in which at least two adjacent helical paths have the same diameter.

8. A tool body comprising an elongated body member having an arcuate face of at least 45° with a plurality of recesses formed in said arcuate face, each said recess having a flat bottom face inclined inwardly and rearwardly within 1-15° of coincidence with the longitudinal axes of the body and an abutment wall extending upwardly from and rearwardly surrounding said flat bottom face, said recess bottom faces lying on helical paths about said tool body arcuate face to form a series of spaced helical rows of recesses with a helical path at one end of said tool body having a diameter greater than that of a helical path at the other end of said tool body and the recesses of each row being staggered circumferentially with respect to the recesses of the next adjacent row whereby the paths of successive recesses partially overlap, said recesses being adapted to hold cylindrical cutter discs, each having an end face providing a cutting edge disposed about the periphery thereof.

9. A tool body constructed substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

10. A cutting tool constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1979.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.